



MULTI POINT SEAT BELT ANTI-SUBMARINING SEAT-BELT ASSEMBLY

CROSS REFERENCE TO RELATED APPLICATIONS

This is a divisional application of the US serial number 09/554,463 related to an international application number PCT/DE98/03270 (WO 99/24294, European Patent EP 1 037 773 B1, German Patent DE 197 49 780 C2) filed Nov. 10, 1998.

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BACKGROUND OF THE INVENTION

1. Field of the Invention:

It is an object of the present invention to ensure-prevent the restraint of a restrained passenger of a transport system (motor vehicle, ship, train or aeroplane) from submarining in order to enhance the survival chance associated with lowering all acceleration-dependant forces in the event of any accident (front-, side-, rear-end collision and/or rollover or pile up/mass collision) of a transport system (a motor vehicle, a train or an aeroplane) or during in-flight turbulence-related vibrations of an aeroplane

2. Discussion of the Prior Art:

It is known in the prior art to provide for a passenger of a transport system an anti-submarining device in order to prevent severe/fatal injury in an accident.

~~— a three-point seat belt (safety belt or lap-shoulder seat belt assembly), mounted in the motor vehicle, consisting of a shoulder belt extending across the upper part of his body and of a lap belt extending across the lower part of his body; or~~

~~— a two-point seat belt, mounted in the aeroplane, acting as lap belt extending across the lower part of his body; or~~

~~— a suspender (waist-) belt consisting of several pieces (belt members).~~

In order to formulate in single terminology a generalized definition is presented for the proper term:

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**Definition:**

**Proper Term:**

"Stiff first transport-system member"

Floor 6 of the transport system adjacent to a first seat-side SR (Fig. 1) or seat-cushion frame at the first seat-side or mid-tunnel (not drawn) of the motor vehicle adjacent to the first seat-side.

"Stiff second transport-system member"

Floor 6 of the transport system adjacent to a second seat-side SL or seat-cushion frame at the second seat-side or post section (not drawn) of the motor vehicle adjacent to the second seat-side or side rail of the motor vehicle adjacent to the second seat-side

"Seat frame"

Seat-cushion frame or seat-backrest frame

It is well known to provide different restraint systems in vehicles, predominantly, three point seat belts in various types for seats, exemplified by DE 37 41 831 A1 shown in Fig. 11. In order to prevent whiplash front seats of SAAB 9-5 cars are equipped with active head restraints (rests) that, each activated by the mass inertia force of the upper body (torso) in rear-end collisions, move up and closer to head of the front-seated occupant. See shortcomings, undermentioned.

In collaboration with Autoliv Corp., the biggest car-supplier in the world, Volvo Corp. has developed WHIPS (Whiplash Injury Prevention System), installed in the front seats of Volvo S80s. Under load of mass inertia forces of a passenger's torso in a rear-end collision the hinge of the seat backrest yields and partially rotates backwards and downwards to facilitate the head rest to intercept the head and the seat backrest, filled with pads, to absorb forces. When a car crashes into the rear section of a S80 and both catch fire, the front-seated passengers and their seat backrests, rotated backwards and downwards, impede the evacuation of the back-seated passengers, who may be severely injured. The front-seated passengers must sit up in order to take further action. Taken as given, the rotated seat backrests cannot be returned to the home position precious time elapses to step out of the car. This raises the question of how the unscathed passengers and/or unscathed back-seated children, exposed to explosion, burn and/or toxic smoke, can evacuate themselves out of the car and/or how rescue workers can evacuate all the severely injured back-seated passengers.

Due to lack of space, in which the SAAB and Volvo protective devices should be installed, heads of rear-seated passengers are unprotected, hence, subjected to whiplash and severe/fatal injury resulting from submarining. For sure, both protective devices remain ineffective in a multi-crash when the front-seated passengers, being submarining underneath their respective lap belt portions, is crushed into death by the airbags, deployed in the front-end crash or falsely deployed in the rear-end crash.

Exemplified in DE 43 36 351 A1 (US serial no. 979,938), a pan, moveable along a pair of rails beneath the seat cushion, is activated in a rear-end collision and moved out therefrom to intercept a submarining passenger when falling down therefrom. Ref. to EP 0 403 072 A2 (US serial no. 364,765) a pair of U-shaped ramps is built in a rear seat. Each ramp comprises two longitudinal members, both fastened to the vehicle floor, and a lateral member, which, arranged along the front portion of the rear seat, intercepts a submarining passenger in a rear-end collision.

Both anti-submarining devices can never prevent severe/fatal injuries linked to great belt force, deployed or falsely deployed airbags, different weights and/or different body proportions.

When a Ford Mondeo, swerving on a road outside the city Idstein, crashes twice into a barrier and finally into a bus, the face of an obese female driver, submarining, is fractured and crushed by the airbag into her skull. In a real-world accident at far higher speed and strong yaw-acceleration great rotatory- and longitudinal-acceleration dependant forces (Figs. 4, 5) enormously elongate the lap belt portion underneath which the belted passenger submarines in the direction „Z<sub>E</sub>“ due to the limitation of the belt pretensioner which can only retract the seat belt up to 30 cm. This accident report is incorporated herein.

Any belted passenger, lying in a sleeping position ref. to DE 37 41 831 C2 (Fig. 7), submarines when being loaded by great mass inertia force „S<sub>y</sub>“ in the direction „Z<sub>E</sub>“ in the event of accident.

In view of foregoing shortcomings and deficiencies, there is a need to ensure the restraint of any passenger as well as the operation of the anti-submarining devices in any accident.

It is well known to provide different restraint systems in vehicles, predominantly, three-point seat belts in various types for seats, exemplified by DE 37 41 831 A1 shown in Fig. 11.

Evidently, when both shoulders of a passenger, conventionally belted, are not restrained in the event of an arbitrary collision with another vehicle in any direction, shown in Figs. 3, 4 and 7,

the unrestrained shoulder can always move and/or rotate freely, thereby resulting in severe/fatal injuries in real-world accidents when

— the head crashes into the steering wheel and/or window pane and/or

— the airbag crushes the head, which, loaded by the forces related to pitch acceleration  $\ddot{U}_H$ ,

yaw acceleration  $\ddot{O}$ , longitudinal and/or lateral acceleration, is in "oop" (out of position).

Moreover, by the definition of „submarining“ the belted passenger submarines (slips downward) under his seat belt thus negating the protective effect of the seat belt.

It is well known to provide two-point or lap seat belts for aeroplane seats as well as mid-portion of the rear seats of motor vehicles. This lap seat belt is far less effective than a three-point seat belt. Due to very large accelerations during a turbulence-related flight the protective effect is very low.

A substantially improved protection is proposed by two different configurations of a one-piece seat belt, exemplified by DE 26 02 875 A1 (Figs. 8 to 10). An „X-shaped“ restraint is arranged by extending both shoulder belts crosswise over the upper part of body while the lower part of body is restrained by the lap belt. Each end of the one-piece seat belt is connected to a belt retractor, fastened in the seat backrest. Two grab rings, positioned to the headrest, move along the belt. A single or double „X-shaped“ configuration is defined by pulling a pair of grab rings and belt portions over the head, shoulders and head rest and engaging them in the corresponding hooks. Due to such intricate operation the seat belt remains unused.

According to US 3,977,696, US 5,123,673, US 5,411,319, DE OS 23 45 847, DE OS 28 13 888 and DE 196 29 878 A1 the restraint system comprises a three-point seat belt, a second shoulder belt and two belt retractors, responsible for retracting both belts. The „X-shaped“ configuration, formed by extending both belts crosswise over the upper part of the body, has the following drawbacks in the event of an accident:

**D1.** Both belts are retracted to different length by two independently operating belt retractors within milliseconds.

**D2.** Under the load of the same belt force in a front collision the deformation of seat backrest, wherein both belt ends are fastened, is larger, thus increasing the forward motion.

Furthermore, it is impossible to attach an energy absorber because all four belt ends are occupied.

A one-piece seat belt 1 (Fig. 1) ref. to DE-OS 28 13 888 is equipped with two belt retractors (not drawn), fastened to both belt ends in the seat backrest, and a belt deflector 17, anchored to the seat frame 3.3 of the mid-portion of rear seat. The feature, proposed for a child, has the following drawbacks:-

5 ~~D3. When the release button 84 is depressed, the belt portion 1.1 gets entangled around the neck of passenger. For the operation of restraining and extending both belt portions into the „X-shaped“ configuration, the passenger must lower his head first.~~

~~D4. Because all belt ends are occupied, it is impossible to attach energy absorbers and to adjust the belt to the size of an upper part of body 95 of an adult.~~

10 Generally, a child seat is fastened by four auxiliary belts to the seat. Despite the „X-shaped“ configuration of a one-piece seat belt to restrain a child, sitting in a child seat, ref. to FR 2 342 872 A1 the problems, associated with the retraction of four auxiliary belts, submarining and energy absorption, remain unsolved in an accident.-

Till now, trains, school buses and buses are not provided with restraint systems.

## SUMMARY OF THE INVENTION

Accordingly, the principle object of the present invention is to provide for passengers of a transport system anti-submarining seat-belt assemblies which resolve the above-mentioned  
20 shortcomings and deficiencies, prevent submarining, absorb impact energy and are suited for two-, three- and multi-point seat belts.

seat belts, each, equipped with a belt retractor, solely responsible for retraction, blocking and tightening or for protraction, a lower belt deflector to loosely guide a belt portion and multi-attachment points (multi-points of restraint), restrains a passenger in multi-attachment  
25 points, in order to lower and distribute the acceleration-dependent loads, shown in Fig. 3 and Tables 1 to 3, to the multi-attachment points in the event of any accident thereof or turbulence-related vibrations of an aeroplane. Nowadays, belt tighteners are incorporated into belt retractors, for example, of MB 500 SL in order to save costs, assembling time and space. A second object of the present invention resides in a user-friendly belt-feeding device to ease  
30 the restraint and in one-click operation by means of a master release button, when depressed, to release the main and anti-submarining all-latch plates from the respective buckle assemblies

and/or return the belt feeding device to the home position. In emergency cases paramedics and fire-fighters can easily rescue the injured passengers.

A third object of the present invention resides in a cost-, space-saving integration of ~~the a~~ multi-point seat belt, equipped with energy absorbers, the anti-submarining seat-belt assembly and the seat into a safety seat, which can be converted into a baby-cot, child-seat or safety-adult seat and vice-versa, illustrated in **Figs. 1, 235**.

#### INDUSTRIAL APPLICABILITY

It should be apparent that the invention provides a substantially improved restraint including the following features:

a) The survival chance is enhanced by the restraint of

- \* both shoulders and the torso, when the passenger is thrown forward (**Fig. 4, Table 3**) and/or subjected to the yaw  $\ddot{O}$ -acceleration-dependent torque  $T_{\delta}$ , and
- \* both thighs and the lower ~~part of the~~ body, when the passenger submarines.

b) ~~Because the belt retractor is attached to one belt end, a~~ number of sets of energy absorbers ref. to US serial no. 09/554,464 (WO 99/24292, (PCT/DE98/03271, European Patent EP 1 037 771 B1, German Patent DE 197 58 498 C2, pending US and CA pending patent 2,314,345) or German Patent DE 197 58 497 C2 can be attached to coupling fittings of anti-submarining seat belt assemblies the other belt end (Figs. 123a, 123b, 183c).

~~Hence, thus gradually absorbing~~ large impact energy can be gradually absorbed below the respective injury-related values. Several sets of energy absorbers can be attached to a length-adjustable belt of the anti-submarining seat belt assembly 8b, 8c (Fig. 1). The inventor of the present application has submitted those patent documents and applications to CIPO as well as USPTO. The energy absorber consists of a number of clamping elements, having sites of predetermined fracture, and a retaining element, which, fastened to the seat backrest frame and/or seat frame, can serve as an integral part thereof.

c) Owing to the different positions of anti-submarining buckle assemblies, in plug-in connection with the respective anti-submarining latch plates, passengers of different body proportions, thighs and weight can adjust the length of the anti-submarining belt portions 1.3R, 1.3L belts by themselves. Moreover, the adult seats, equipped therewith, ~~for adults~~ can be modified for children and vice versa, thus ~~augmenting~~ increasing the rate of seat occupancy in a bus, train or an aeroplane, exemplified in **Fig. 235**. In another embodiment

the length-adjustable belt of the anti-submarining seat belt assembly 8b, 8c facilitates, for example, a female passenger to adapt the belt length to her long gown or to herself, when lying in sleeping position (Figs. 1, 7).

5 e) ~~In another embodiment an upper belt deflector 5b (Fig. 15), in plug-in connection with the buckle assembly 4, or the buckle assembly 4 is height-adjustable. Energy absorbers, above-mentioned, can be connected to this buckle assembly. Upon the use of the height-adjustable belt deflector 5b the height-adjustable D-ring 12, attached to the B-, C-, D-post section (pillar, pillar portion), shown in Fig. 1, or to the top edge of the seat backrest, is no longer needed. When the belt deflector 5b is not height-adjustable, it can be connected to energy absorbers which absorb energy and dampen vibration when the first shoulder belt portion moves it up.~~

10 d) ~~In another embodiment the upper belt deflector 5a (Fig. 13) can be rigidly attached to the head rest 3.6a. Any adjustment of the height of the head rest 3.6a to the head automatically adjusts the height of the upper belt deflector to the shoulder. This feature differs from the D-ring ref. to DE 40 10 452 A1, which is in contact with the shoulder belt, when the passenger is thrown forward, and is moved up to intercept the head, when thrown backward.~~

15 d) For safety reasons and easy access the anti-submarining latch plates 11, 25, when not being used, are stored in a storage box 25.5 (Fig. 5). The belt-detachable anti-submarining latch plates 25 (Fig. 2) are attached to the lap belt portion when needed.

20 i) ~~e) For the convenience of the passenger, when stepping out, or for a quick- fast rescue of the passenger injured, when being rescued in an accidents, the master release button 84 of the buckle assembly 9.1 is depressed to release all latch plates from the buckle assemblies and/or to return the belt-feeding device to the resting (home) position.~~

25 g) ~~The round rollover tubes 20.2b of the seat backrest frame 3.4d are designed to guide the belt housing 20.4c, 20.4d (Figs. 18, 19), to act as safety bars in a rollover and to allow free view to the rear owing to openings 97R, 97L (Fig. 23).~~

30 h) ~~In another embodiment the seat belt can be connected to the seat in more than three attachment points (Figs. 1, 14, 23), in which both thighs (femurs) are restrained, thus protecting the passenger from submarining in a front, rear collision or rollover or when in sleeping position. Unlike the suspender (waist-) belt, consisting of several belts, the~~

portions of multi-point seat belt need not be adjusted in length, when the circumference of the passenger varies depending on the clothes worn.

## BRIEF DESCRIPTION OF THE DRAWINGS

A number of embodiments, other advantages and features of the present invention will be described in the accompanying tables and drawings with reference to the xyz global coordinate system:

**Table 1** shows test data such as left / right thigh-force, belt force and pitch-angle of driver and co-driver in 50% offset crash test of several European vehicles at crash speed of 55 km/h.

**Table 2** shows yaw angle  $\Theta$  of driver / co-driver in a 50% offset crash tests.

**Table 3** shows test data of the safest child-restraint system Chico Shuttle® at the converted velocity of 55 km/h in comparison with the safest vehicle among them listed in **Table 1.**

**Fig. 1** is a perspective view of a seat with upper buckle assemblies and anti-submarining buckle assemblies 7, 8, 8a to 8d, attached to the seat backrest and seat cushion, as well as of a the 1st embodiment of restraint system consisting of a multi-point seat belt 1, latch plate 11 along the lap belt. shoulder latch plate 2 of belt end, in the direction of arrow „Z” in plug-in connection with an upper buckle assembly 4, and a seat belt in X-shape, formed by crossing both shoulder belt portions 1.1, 1.2.

**Fig. 162** is a schematic view of a detachable anti-submarining latch plate 25 ~~the 2nd and 3rd embodiment of spatially adjusting belt feeding devices 20a and 20b in kinematics from the operating position to the resting position in x-y plane.~~

**Fig. 123a** is a schematic, perspective view of thea 1st 1<sup>st</sup> embodiment of a buckle assembly 4a, equipped with a release cable 4.2.

**Fig. 123b** is a schematic, perspective view of thea 2nd 2<sup>nd</sup> embodiment of a buckle assembly 4b, equipped with an electrical release-motor 4.2b.

**Fig. 213c** is a schematic, perspective view of a 3<sup>rd</sup> embodiment of a buckle assembly 4c, equipped with a release cable 4.3. ~~a cross-sectional view of the height- and width-adjusting mechanism 27 along the line II-II of Fig. 20.~~

**Fig. 144** is a perspective view of a anti-submarining latch plate 11 of a lap belt portion 1.3 in plug-in connection with a the anti-submarining buckle assembly 8 and of the 1st embodiment of a belt feeding device 20 of the seat belt.



Fig. 235 is a front view of the seat 3a to 3d, in which the restraint systems 1a to 1d, anti-submarining seat-belt assemblies and storage boxes 25.5 are integrated, for passengers of different weights, different circumference of thighs and different body proportions (sizes), where anti-submarining buckle assemblies are in plug-in connection with the anti-submarining latch plates 11, 25.

Fig. 6 illustrates two curves of strain/elongation rate dependent from force ref. to PCT/US99/13362 (US 09/098,294).

Fig. 417 is a top view of a  $\angle$ - shaped seat belt ref. to DE 37 41 831 A1, where a belted passenger, in sleeping position, under load of great mass inertia force „S<sub>y</sub>“ in the direction „Z<sub>E</sub>“ submarines.

Fig. 2 is a perspective view of a seat and of the 2nd embodiment of a restraint system comprising three-point seat belt 1e having a transition latch plate 2, which will be inserted into a transition buckle assembly 4e of a shoulder belt 1.11, pulled in the direction of arrow „Z“.

Fig. 3 illustrates load cases I, II and III in z-y plane in the event of a real-world accident.

Fig. 4 is a perspective view of a restrained dummy thrown forward in VW Polo® in a 50% offset crash test.

Fig. 5 illustrates a yaw acceleration  $\ddot{O}$  and yaw angle  $O$  of a vehicle about the vertical axis „z<sub>A</sub>“ in a 50% offset crash test of two identical vehicles.

Fig. 6 illustrates a yaw angle  $O$  of vehicle about the vertical axis „z<sub>A</sub>“ in a 50% offset crash test into a stiff barrier.

Fig. 7 illustrates four collision types „U1“ to „U4“ ref. to the research work of Institute of Vehicle Safety, a Dept. of German Insurers Association.

Fig. 8 is a front view of a seat belt ref. to DE-OS 26 02 875 in home position.

Fig. 9 is a front view of a double X-shaped seat belt ref. to DE-OS 26 02 875.

Fig. 10 is a front view of a single X-shaped seat belt ref. to DE-OS 26 02 875.

Fig. 13 is a perspective view of an upper belt deflector of the head rest.

Fig. 15 is a perspective view of the 2nd embodiment of a spatially adjusting belt feeding device 20a from the resting position to the operating position and of a height-adjustable belt deflector 5b.

Figs. 17a to 17f are schematic, perspective views of the belt feeding device 20 in kinematics from the resting position to the operating position.

Fig. 18 is a schematic, perspective view of a seat, equipped with the rollover tubes 20.2b, and of the 4th embodiment of a belt-feeding device 20e.

Fig. 19 is a schematic, perspective view of a seat having the rollover tubes 20.2b, the 5th embodiment of a belt-feeding device 20d, provided with a safety bracket 20.6, a height- and width-adjusting mechanism 27, 27a.

Fig. 20 is a cross-sectional view of the 1st embodiment of the height- and width-adjusting mechanism 27 along the line I-I of Fig. 19.

Fig. 22 cross-sectional view of the 2nd embodiment of the height- and width-adjusting mechanism 27a along the line I-I of Fig. 19.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS OF THE INVENTION

The advantages of the preferred embodiments in the Chap. "INDUSTRIAL APPLICABILITY" are outlined hereinafter with regard to the functions and features thereof.

Just at a crash speed of 55 km/h the belt force of a driver of the premium car AUDI A8 is measured 9,130 N (Table 1) equivalent to 2,015 Pound by which the seat belt is elongated (strained) about 19 % (Fig. 6). The elongation ranges from 47.5 to 57 cm when the seat belt is 2.5 to 3 m long. In case the belt pretensioner remains inoperative and, in particular, the total mass inertia force „S<sub>y</sub>“ of the lower body is far larger than that of the upper body the passenger slips (submarines) underneath the lap belt portion in a real-world accident. The method of the present invention capitalizes on the premise that a lap seat-belt portion, is employed to restraining a lower body of the belted passenger, is subdivided into two anti-submarining belt portions 1.3R, 1.3L which properly restrain as well as hold his thighs when plug-in connecting at least one anti-submarining latch plate 11, 25 to the respective one of anti-submarining buckle assemblies 7, 8, 8a to 8d, all of which are equipped with energy absorbers, shown in Figs. 1, 4 and 5. As a result, the anti-submarining seat-belt assembly in association with energy absorbers

- substantially lowers large belt force, for example, of 15,190 N at only 55 km/h (Table 1), in a real-world accident or during in-flight turbulence,
- prevents large elongation of the seat belt webbing, severe/fatal injury and the passenger of a Mercedes Car, lying in the sleeping position (Fig. 7), from submarining and

– ensures the operation of the active head restraint of SAAB 9-5 and Volvo's WHIPS.

in at least four attachment points of the seat to distribute all acceleration dependant loads, particularly the yaw  $\ddot{O}$  acceleration dependent torque  $T_\delta$ , thereto in an accident, thus ensuring the operation of a single belt retractor to pre-tension (bias) as well as tension the belt, restraining both shoulders, upper and lower part of the body and lowering all the loads, in particular, in co-operation with the energy absorption when a number of sets of energy absorbers is put into use. This will be apparent when all forces, imposed on the belted passenger, shown in Figs. 3 and 4, are formulated in the event of a front collision, where the loads of the mass  $D_s$  of the torso are lowered because

— the forward motion „ $w_v$ ” is minimized, thus substantially reducing the pitch acceleration  $\ddot{U}_H$  and force  $F_{Hy}$  of the mass  $D_H$  of the head, and  
— the yaw acceleration  $\ddot{O}$  is minimized, thus substantially reducing the torque  $T_\delta$ , imposed on the head. Great torque  $T_\delta$  is the most latent force, responsible for sudden death.

To a great extent massive head injuries can be avoided.

Load case I in z-y plane: The rotating mass  $D_s$  rotates about the rotating axis „S” at the pitch angle  $U_s$  and mass  $D_H$  about the rotating axis „z” at the pitch angle  $U_H$  in Table 1, thereby resulting in the pitch accelerations  $\ddot{U}_s$ ,  $\ddot{U}_H$  and rotating forces  $F_{sy}$ ,  $F_{Hy}$ . The addition of both rotating forces yields the force  $F_v$  linked to the forward motion  $w_v$  of passenger, shown in Fig. 4.

In front and/or rear collision the passenger is exposed to the submarining force  $S_y$ , shown in Fig. 14.

Load case II in x-y plane: The upper part of body is subjected to the torque  $T_\delta$ , exerted by the yaw acceleration  $\ddot{O}$  about the rotating axis „z”. When the upper part is restrained in an X-shape, the torque is substituted by a pair of forces.

Load case III in x-z plane: The rotating mass  $D_s$  rotates about the rotating axis „S” at the rotating angle  $U_y$  and mass  $D_H$  about the rotating axis „z” at the rotating angle  $U_{Hy}$ , thereby resulting in the rotating accelerations  $\ddot{U}_y$ ,  $\ddot{U}_{Hy}$  and rotating forces  $D_{sy}$ ,  $D_{Hy}$  (not drawn). In a rollover the passenger is subjected to the load  $F_{sz}$ .

Load case IV: In turbulence-related vibrations of an aeroplane the load  $D_{sy}$  together with  $D_{Hy}$  takes the form of periodical load  $\pm F_{Hx}$ ,  $F_{Sz}$  of  $\pm F_{Sz}$ ,  $T_{\theta}$  of  $\pm T_{\theta}$ ,  $S_y$  of  $\pm S_y$  and  $F_{Sy}$  together with  $F_{Hy}$  of  $\pm F_y$ .

The restraint system, illustrated in Fig. 1, is provided with a conventional belt retractor 13 having a clamping device, housed in the B, C, D post section or in one of both sides SL and SR of a seat backrest 3.2 and connected to the belt end EL. The other belt end ER is provided with a shoulder latch plate 2, which is retained, loosely guided by a lower belt deflector 17, fastened to the vehicle floor, and inserted into one of the buckle assemblies 4, 4a to 4c, 14, 14a, 18, 18a, 18b, arranged in or to the seat backrest 3.2. In all embodiments an additional latch plate 9 can move along the seat belt 1 between both belt ends EL and ER. When plug-in connecting the shoulder latch plate 2 (in the direction of arrow "Z") to the buckle assembly 4 and the latch plate 9 to the buckle assembly 9.1, an X-shaped restraint of the upper part of body and both shoulders as well as a restraint of the lower part of body are accomplished by both belt portions 1.1, 1.2 and the lap belt portion 1.3.

In the 2nd embodiment, shown in Fig. 2, a transition product, comprising conventional three-point seat belt 1e and new parts, has to be invented due to the delay resulting from the production of multi-point seat belts 1. The floor fitting (not shown) is replaced by lower belt deflector 17. The end of the lower shoulder belt portion 1.11 is provided with transition latch plate 2. The end of an upper shoulder belt 1.12 and the other end are equipped with a transition buckle assembly 4e, having release button 84e, and with a second belt retractor 13a, arranged in the seat backrest 3.2. The restraint in an X-shape is defined by plug-in connection of transition latch plate 2 with the transition buckle assembly 4e. In order to resolve the above-mentioned drawback D1, the spring force of the second belt retractor 13a, to retract the shoulder belt 1.12 on depressing the release button 84e, is far less than of the belt retractor 13. Despite the circumference of the restrained passenger, varying depending on the clothes worn, and the different seat position the shoulder belt portion 1.11 always projects through the lower belt deflector 17 at a sufficient length of "l<sub>1</sub>" in order to maintain the function of the belt retractor 13 to retract, to block the belt as well as to release the retracted belt during the travel and the function of the belt tightener (not drawn), incorporated in the belt retractor, to forcefully retract (withdraw) and tighten the belt in an accident. In an embodiment tThe release button 84ef, 84e of free-moving transition anti-submarining buckle assembly 4e8b, 8c

(Fig. 1), whose housing is free-moving on the seat cushion and whose length-adjustable belt is fastened arranged to or in the seat frame, can be controlled neither by a release cable 4.2 nor by an electrical release-motor 4.2b. Hence, the release button 84ee, 84f can only be activated by an electrical signals emitted from when depressing the master release button 84, when depressed, to remove the protection from submarining.

The other end of shoulder belt 1.12 can be connected either to a coupling fitting 1.2a, 1.2b (Figs. 12a, 12b, 18, 19) or to the belt retractor 13a (belt retractor 13 shown in Fig. 18) having a coupling fitting 1.2b in order to receive a number of energy absorbers to dissipate great impact energy and dampen strong vibration.

In another embodiment the shoulder belt 1.12a consists of the transition buckle assembly 4e and a shoulder latch plate 2a (not shown), similar to latch plate 2, which is plug-in connected to

—the upper buckle assembly 4, 4a to 4c, 14, 14a, 18, 18a, 18b, 18.1 to 18.3, arranged in the seat backrest, in operation position or

—the assisting buckle assembly 16, 16a, 16b in resting position.

When motor vehicles are already licensed, modification of different seats and three-point seat belts can easily be accomplished by arrangement of at least one buckle assembly, of the lower belt deflector 17, of the second belt retractor 13a and by collection of one piece, detachable shoulder belts 1.12a with different length. Furthermore, the latch plate 2a can be detached from the buckle assembly by depressing the master release button 84.

A first shoulder belt portion 1.1 is defined by the upper shoulder belt 1.12, 1.12a and the lower shoulder belt portion 1.11.

At an expensive modification or at new transport system the use of belt feeding device 20, 20a to 20d enhances the convenience and comfort, where the shoulder belt 1.12, 1.12a having transition buckle assembly 4e is a part thereof.

Evidently, the three-point seat belt 1e in plug-in connection with the shoulder belt 1.12, 1.12a serves as a transition solution for the multi-point seat belt 1, 1a to 1d during the production.

In the above-mentioned embodiments to resolve the above-mentioned drawback D3 the upper part of body is restrained by extending the shoulder belt portions crosswise in an X-shape

e1) when at least one latch plate 2 is plug-in connected to the buckle assembly of the seat backrest; or

e2) when a latch plate **2**, arranged to the end ER of the first shoulder belt portion **1.1** of a belt feeding device **20a, 20b**, is plug-in connected to the buckle assembly of the seat backrest;  
or

e3) when the belt feeding device **20, 20c, 20d** positions the first shoulder belt portion **1.1**, the belt end ER of which is arranged to or in the side SR of the seat backrest, from the operation position to a resting position.

These features e2) and e3) have the advantage that the common practise to operate the conventional three-point seat belt is preserved.

In order to resolve the above-mentioned drawbacks **D2** and **D4** great energy is absorbed and strong vibration is dampened by a large number of energy absorbers connected to the respective buckle assemblies **4, 4a to 4c, 4e, 7, 8, 8a to 8d, 9.1, 14, 14a, 15, 15a, 18, 18a, 18b, 18.1 to 18.3, 19, 19a, 19b, 19.1 to 19.3** (Figs. 1, 14, 19, 23) into which latch plates are inserted.

As shown in Figs. 1 and 14, the seat belt **1** is equipped with an anti-submarining latch plate **11**, which can be connected to one of the buckle assemblies **7, 8, 8a to 8d**, arranged in or to the seat frame **3.3**. When plug-in connected, the lap belt portion **1.3** is subdivided into two belt portions **1.3R, 1.3L**. Owing to the restraint of both thighs the submarining problem in front or rear collision, in rollover or turbulence-related vibration of an aeroplane is resolved. Moreover, the passenger, lying in a sleeping position, is well protected.

Because the reel (spool) of the conventional belt retractor can accommodate only a limited length of belt, it is possible that the length of the seat belt for the sleeping position is insufficient. As exemplified in Fig. 1, a buckle assembly **8b, 8c** is provided with a release button **84c** and a The length-adjustable belt, fastened to the seat frame, for the purpose of compensatesing for the length of seat belt 1 and accommodates the passenger, particularly when being

obese, in all positions between the sleeping and normal position.

An anti-submarining buckle assembly **8d**, provided with a release button **84d**, is attached to the front portion of the seat cushion. This feature facilitates the obese passenger or a lady in a gown to restrain the thighs by plug-in connecting the anti-submarining latch plate 11 thereto.

The other end of shoulder belt **1.12** can be connected either to a coupling fitting **1.2a, 1.2b** (Figs. 12a, 12b, 18, 19) or to the belt retractor **13a** (belt retractor **13** shown in Fig. 18) having

a coupling fitting ~~1.2b~~ in order to receive a number of energy absorbers to dissipate great impact energy and dampen strong vibration.

In another embodiment the shoulder belt ~~1.12a~~ consists of the transition buckle assembly ~~4e~~ and a shoulder latch plate ~~2a~~ (not shown), similar to latch plate ~~2~~, which is plug-in connected to

— the upper buckle assembly ~~4, 4a to 4c, 14, 14a, 18, 18a, 18b, 18.1 to 18.3~~, arranged in the seat backrest, in operation position or

— the assisting buckle assembly ~~16, 16a, 16b~~ in resting position.

When motor vehicles are already licensed, modification of different seats and three-point seat belts can easily be accomplished by arrangement of at least one buckle assembly, of the lower belt deflector ~~17~~, of the second belt retractor ~~13a~~ and by collection of one piece, detachable shoulder belts ~~1.12a~~ with different length. Furthermore, the latch plate ~~2a~~ can be detached from the buckle assembly by depressing the master release button ~~84~~.

A first shoulder belt portion ~~1.1~~ is defined by the upper shoulder belt ~~1.12, 1.12a~~ and the lower shoulder belt portion ~~1.11~~.

At an expensive modification or at new transport system the use of belt feeding device ~~20, 20a to 20d~~ enhances the convenience and comfort, where the shoulder belt ~~1.12, 1.12a~~ having transition buckle assembly ~~4e~~ is a part thereof.

Evidently, the three-point seat belt ~~1e~~ in plug-in connection with the shoulder belt ~~1.12, 1.12a~~ serves as a transition solution for the multi-point seat belt ~~1, 1a to 1d~~ during the production.

In the above-mentioned embodiments to resolve the above-mentioned drawback ~~D3~~ the upper part of body is restrained by extending the shoulder belt portions crosswise in an X-shape

e1) when at least one latch plate ~~2~~ is plug-in connected to the buckle assembly of the seat backrest; ~~or~~

e2) when a latch plate ~~2~~, arranged to the end ER of the first shoulder belt portion ~~1.1~~ of a belt feeding device ~~20a, 20b~~, is plug-in connected to the buckle assembly of the seat backrest; ~~or~~

e3) when the belt feeding device ~~20, 20c, 20d~~ positions the first shoulder belt portion ~~1.1~~, the belt end ER of which is arranged to or in the side SR of the seat backrest, from the operation position to a resting position.

These features c2) and c3) have the advantage that the common practise to operate the conventional three-point seat belt is preserved.

In order to resolve the above-mentioned drawbacks ~~D2 and D4~~ great energy is absorbed and strong vibration is dampened by a large number of energy absorbers connected to the respective buckle assemblies 4, ~~4a to 4c, 4e, 7, 8, 8a to 8d, 9.1, 14, 14a, 15, 15a, 18, 18a, 18b, 18.1 to 18.3, 19, 19a, 19b, 19.1 to 19.3~~ (Figs. 1, 14, 19, 23) into which latch plates are inserted.

As shown in Figs. 1 and 14, the seat belt 1 is equipped with an anti-submarining latch plate 11, which can be connected to one of the buckle assemblies 7, 8, ~~8a to 8d~~, arranged in or to the seat frame 3.3. When plug-in connected, the lap belt portion 1.3 is subdivided into two belt portions 1.3R, 1.3L. Owing to the restraint of both thighs the submarining problem in front or rear collision, in rollover or turbulence-related vibration of an aeroplane is resolved. Moreover, the passenger, lying in a sleeping position, is well protected.

Due to the plug-in connection of the anti-submarining latch plates 11, 25 with one of the anti-submarining buckle assemblies a lady in a long gown as well as a child are well protected from submarining. The anti-submarining belt portions, restraining a child's or baby's thighs with small circumference, are secured to the seat cushion by the latch plate 11, plug-in connected to one of the anti-submarining buckle assemblies 8, 8a to 8d, and the detachable anti-submarining latch plates 25, plug-in connected to at least one pair of anti-submarining buckle assemblies 7 (Figs. 1, 235). For safety reasons and easy access the anti-submarining latch plates, when not being used, are stored and secured in a storage box 25.5 of the seat (Fig. 5).

The lower belt deflector 17 comprises a housing having an attachment hole to receive a pin 17.1. Both members can be made in one piece. If necessary, the pin 17.1 is surrounded by a sleeve 17.2 of plastics, having corrugation or knobs, which is a common part of the conventional D-ring 12. This D-ring 12 can be replaced by the lower belt deflector 17. The aperture of the belt deflector 17 to loosely guide the belt portion is dimensioned to such a size to retain the latch plate 2 in resting position, thus allowing the use as a three-point seat belt.

In the 1st embodiment ref. to Figs. 14, 17a, 17d the belt feeding device 20 in resting position is provided with a device to countersink the belt feeding plate 20.9 in the seat



backrest to improve the overall impression of the seat design, whereon the sales success depends.

When the passenger takes his seat, a drive apparatus, being activated,

—moves up over the head rest the belt feeding plate 20.9 (Fig. 17a) and then the guide tube 20.1 with the operating arm 20.2, whose belt ring 20.8 houses and loosely guides the first belt portion 1.1 (Fig. 17b);

—rotates the operating arm and the first shoulder belt portion over the head rest, his head and in front of the upper part of his body 95 at „ $\beta$ ” (Fig. 14), where in a contact position a key of the operating arm projects through a receptacle of the belt feeding plate 20.9 or a clamping receptacle 20.11 of the belt feeding plate 20.9a (Figs. 17c, e, f); and

—countersinks the belt feeding plate 20.9 or 20.9a and the guide tube 20.1 with the operating arm 20.2 until reaching the operating position in which the first shoulder belt portion extends across over the upper part of his body and the drive apparatus is switched off (Fig. 17d).

To prevent the entanglement of the first belt portion 1.1 behind the seat, particularly when positioned furthest forward, that belt portion 1.1 in resting position is intercepted by the belt catching member 20.7, 20.7a (Figs. 14, 17a, 17b).

When the seat 3c (Fig. 23) has a high seat backrest, the curved guide tube 20.1 of belt feeding devices 20a (Fig. 15) can be modified in a straight running operating arm 20.2 of the belt feeding device 20.

In the 2nd or 3rd embodiment the belt feeding device 20a or 20b is provided with a height adjustable belt housing 20.4a and radial adjustable tube 20.3 (Figs. 15, 16). Both devices differ from each other by the position of the guide tubes 20.1 on the seat backrest. Each guide tube can be driven by a drive apparatus, housed in the seat backrest. The guide tube 20.1 of the belt feeding device 20a is pivotally attached in a stiff supporting tube 3.61 of the height adjustable head rest 3.6a.

The height of „ $\Delta h$ ” of belt housing 20.4a, having a latch plate 2, plug-in connected to any buckle assembly 4, 14, 18, is adjustable when the passenger moves two openings, facing each other, along the operating arm 20.2a. Alternatively, the passenger can move a handle 5.2, such as locking handle 27.5 of the height and width adjusting mechanism 27, 27a (Figs. 15, 19 to 22), to adjust the height of „ $\Delta h$ ” of upper belt deflector 5b.

The belt feeding devices ~~20a, 20b~~ have to meet the following criteria:

- ~~— Passengers freely get in and out of the vehicle compartment thanks to the distances of „a” and „b” between the post section 91 and operating arm 20.2a (Fig. 16) in resting position; and~~
- ~~— the device, when moved, doesn't interfere with the head rest 3.6a, height adjustable about „Ah<sub>k</sub>”, and with the head of the passenger with/without hat 92.~~

Regarding the kinematics of the height adjustable belt housing ~~20.4a~~ with the latch plate ~~2~~ from the operating position to the resting position, the trajectories of „Ba2” and „Bb” are not in the range of a hat thanks to a radial adjustable tube ~~20.3~~ incorporated into the operating arm ~~20.2a~~. Without the radial adjustable tube ~~20.3~~ the operating arm in the trajectory of „Ba1” interferes with that hat.

In the 4th and 5th embodiment ref. to Figs. 18, 19 the belt feeding devices ~~20c, 20d~~ differ from each other by the rotatory movement of the operating arm ~~20.2~~, whose guide tube ~~20.1~~ is pivotally attached to a bearing casing ~~20.10~~. Preferably, upon the rotation about the head, the translatory and rotatory movement of belt are synchronised.

To form the upper part of the seat backrest frame ~~3.4d~~ a pair of angle fittings ~~26a~~, a pair of rollover tubes ~~20.2b~~ and a pair of side girders ~~27.1a~~ or four tubes ~~27.1~~ (not drawn) are formed and/or force locking connected to each other by connecting pins ~~26.2, 26.3~~ (drawn with dotted lines) and/or by welding, bolting, glueing and/or riveting. The belt housing ~~20.4c~~ or ~~20.4d~~, having a moveable safety bracket ~~20.6~~, is guided by rollover tubes ~~20.2b~~ and driven by an electrical motor ~~20.5~~ along the threaded spindle ~~20.1a~~, fastened to both angle fittings ~~26a~~, from the resting position (drawn with dotted lines) to the operating position, and back again. In the operating position the holes of the rollover tube ~~20.2b~~ and belt housing ~~20.4d~~ are aligned with each other, thus permitting the legs of the safety bracket ~~20.6~~, loaded in the event of rollover of a convertible, roadster or sport utility vehicle, to project therethrough and clamp or jam the first shoulder belt portion ~~1.1~~.

Upon plug in connection of the latch plate ~~2~~ with the buckle assembly ~~4, 4a, 4b~~ the belt end ER of belt portion ~~1.1~~ is connected to the coupling fitting ~~1.2a, 1.2b~~ (Figs. 12a, 12b), whereto a number of energy absorbers is attached to absorb energy. In a cost saving embodiment without the latch plate ~~2~~ and buckle assembly, the belt end ER of belt portion ~~1.1~~ is directly connected to the coupling fitting ~~1.2a~~ or ~~1.2b~~ (Fig. 18) to receive energy absorbers, the retaining elements of which are fastened to the seat backrest frame ~~3.4d~~. In order to

absorb great energy and damp strong vibration in the event turbulence-related vibrations of an aeroplane or accident of a fast speeding car or high speed train, the belt retractor 13, coupling fitting 1.2b of which is connected to energy absorbers, is moveable attached to the oblong holes of a stiff plate 13.3, fastened to the seat backrest frame in the side SR so that the other belt end EL can be exploited to receive additional energy absorbers. In excess of threshold value the belt retractor pulls the clamping elements along the respective retaining elements to absorb energy and damp vibration.

The lower belt deflector 17 comprises a housing having an attachment hole to receive a pin 17.1. Both members can be made in one piece. If necessary, the pin 17.1 is surrounded by a sleeve 17.2 of plastics, having corrugation or knobs, which is a common part of the conventional D-ring 12. This D-ring 12 can be replaced by the lower belt deflector 17. The aperture of the belt deflector 17 to loosely guide the belt portion is dimensioned to such a size to retain the latch plate 2 in resting position, thus allowing the use as a three point seat belt.

In the 1st embodiment ref. to Figs. 14, 17a, 17d the belt feeding device 20 in resting position is provided with a device to countersink the belt feeding plate 20.9 in the seat backrest to improve the overall impression of the seat design, whereon the sales success depends.

When the passenger takes his seat, a drive apparatus, being activated,

—moves up over the head rest the belt feeding plate 20.9 (Fig. 17a) and then the guide tube 20.1 with the operating arm 20.2, whose belt ring 20.8 houses and loosely guides the first belt portion 1.1 (Fig. 17b);

—rotates the operating arm and the first shoulder belt portion over the head rest, his head and in front of the upper part of his body 95 at „ $\beta$ ” (Fig. 14), where in a contact position a key of the operating arm projects through a receptacle of the belt feeding plate 20.9 or a clamping receptacle 20.11 of the belt feeding plate 20.9a (Figs. 17c, e, f); and

—countersinks the belt feeding plate 20.9 or 20.9a and the guide tube 20.1 with the operating arm 20.2 until reaching the operating position in which the first shoulder belt portion extends across over the upper part of his body and the drive apparatus is switched off (Fig. 17d).

To prevent the entanglement of the first belt portion 1.1 behind the seat, particularly when positioned furthest forward, that belt portion 1.1 in resting position is intercepted by the belt catching member 20.7, 20.7a (Figs. 14, 17a, 17b).

When the seat 3c (Fig. 23) has a high seat backrest, the curved guide tube 20.1 of belt feeding devices 20a (Fig. 15) can be modified in a straight running operating arm 20.2 of the belt feeding device 20.

In the 2nd or 3rd embodiment the belt feeding device 20a or 20b is provided with a height adjustable belt housing 20.4a and radial adjustable tube 20.3 (Figs. 15, 16). Both devices differ from each other by the position of the guide tubes 20.1 on the seat backrest. Each guide tube can be driven by a drive apparatus, housed in the seat backrest. The guide tube 20.1 of the belt feeding device 20a is pivotally attached in a stiff supporting tube 3.61 of the height adjustable head rest 3.6a.

The height of „Ah” of belt housing 20.4a, having a latch plate 2, plug-in connected to any buckle assembly 4, 14, 18, is adjustable when the passenger moves two openings, facing each other, along the operating arm 20.2a. Alternatively, the passenger can move a handle 5.2, such as locking handle 27.5 of the height and width adjusting mechanism 27, 27a (Figs. 15, 19 to 22), to adjust the height of „Ah” of upper belt deflector 5b.

The belt feeding devices 20a, 20b have to meet the following criteria:

- Passengers freely get in and out of the vehicle compartment thanks to the distances of „a” and „b” between the post section 91 and operating arm 20.2a (Fig. 16) in resting position; and
- the device, when moved, doesn't interfere with the head rest 3.6a, height adjustable about „Ah<sub>K</sub>”, and with the head of the passenger with/without hat 92.

Regarding the kinematics of the height adjustable belt housing 20.4a with the latch plate 2 from the operating position to the resting position, the trajectories of „Ba2” and „Bb” are not in the range of a hat thanks to a radial adjustable tube 20.3 incorporated into the operating arm 20.2a. Without the radial adjustable tube 20.3 the operating arm in the trajectory of „Ba1” interferes with that hat.

In the 4th and 5th embodiment ref. to Figs. 18, 19 the belt feeding devices 20c, 20d differ from each other by the rotatory movement of the operating arm 20.2, whose guide tube 20.1

is pivotally attached to a bearing casing 20.10. Preferably, upon the rotation about the head, the translatory and rotatory movement of belt are synchronised.

To form the upper part of the seat backrest frame 3.4d a pair of angle fittings 26a, a pair of rollover tubes 20.2b and a pair of side girders 27.1a or four tubes 27.1 (not drawn) are form- and/or force-locking connected to each other by connecting pins 26.2, 26.3 (drawn with dotted lines) and/or by welding, bolting, glueing and/or riveting. The belt housing 20.4e or 20.4d, having a moveable safety bracket 20.6, is guided by rollover tubes 20.2b and driven by an electrical motor 20.5 along the threaded spindle 20.1a, fastened to both angle fittings 26a, from the resting position (drawn with dotted lines) to the operating position, and back again. In the operating position the holes of the rollover tube 20.2b and belt housing 20.4d are aligned with each other, thus permitting the legs of the safety bracket 20.6, loaded in the event of rollover of a convertible, roadster or sport-utility vehicle, to project therethrough and clamp or jam the first shoulder belt portion 1.1.

Upon plug-in connection of the latch plate 2 with the buckle assembly 4, 4a, 4b the belt end ER of belt portion 1.1 is connected to the coupling fitting 1.2a, 1.2b (Figs. 12a, 12b), whereto a number of energy absorbers is attached to absorb energy. In a cost-saving embodiment without the latch plate 2 and buckle assembly, the belt end ER of belt portion 1.1 is directly connected to the coupling fitting 1.2a or 1.2b (Fig. 18) to receive energy absorbers, the retaining elements of which are fastened to the seat backrest frame 3.4d. In order to absorb great energy and damp strong vibration in the event turbulence-related vibrations of an aeroplane or accident of a fast speeding car or high-speed train, the belt retractor 13, coupling fitting 1.2b of which is connected to energy absorbers, is moveable attached to the oblong holes of a stiff plate 13.3, fastened to the seat backrest frame in the side SR so that the other belt end EL can be exploited to receive additional energy absorbers. In excess of threshold value the belt retractor pulls the clamping elements along the respective retaining elements to absorb energy and damp vibration.

In the 1<sup>st</sup>, and 2<sup>nd</sup> and 3<sup>rd</sup> embodiment (Figs. 12, 213a to 3c) the buckle assembly 4a, 4b, 4c is form- and/or force-locking connected to the seat backrest frame. For the convenience of the passenger when egressing from the vehicle and in cases of emergency the following embodiments of detachment are proposed:

To disconnect the latch plates 2, 11 and/or 25 from the buckle assemblies 14, 14a, 15, 15a (Fig. 1) and upper buckle assemblies 4, 18, 18a, 18b, 18.1 to 18.3, 19, 19a, 19b, 19.1 to 19.3

(Figs. 231 and 5) of the seat arrangement, particularly in the case of ~~for~~ children, as well as from the anti-submarining buckle assemblies 7, 8, 8a to 8d (Figs. 1, 14), the master release button 84, when depressed, activates the release cables 4.2 and/or electrical release-motors 4.2b, which pull the release button 84a and/or 84b of all the buckle assemblies (Figs. 12a3a, 12b3b, 213c).

~~When depressing the master release button 84 the drive apparatus of the belt feeding device 20, 20a to 20d returns the first shoulder belt portion 1.1 from the operating position to the resting position.~~

~~According to the traffic or flight law during the travel or turbulence related flight passengers must remain belted. The need for a belted mother becomes apparent, when she must take care of her frightened children seating on the rear seat. The separately operated release button 84o, 84d, when depressed, detaches only the latch plates 11, 25 of the lap belt portion from the assemblies 7, 8, 8a, 8d (Figs. 1, 23) to annul the protection from submarining.~~

By law passengers travelling in a motor vehicle or experiencing flight-turbulence According to the traffic or flight law during the travel or turbulence related flight passengers must remain belted. The need for a belted mother to turn around becomes apparent, when she must attend take care of her frightened to her children seating sitting on the rear seat. The separately operated release buttons 84o, 84d, 84e, 84f, when depressed, detaches only the anti-submarining latch plates 11, 25 of the lap belt portions from the assemblies 7, 8, 8a, to 8d (Figs. 1, 4 and 235) to free the mother and/or children from the anti-submarining annul the protection from submarining while the mother and/or children remain belted. The anti-submarining buckle assemblies 7, 8, 8a, whose housings are located in the seat cushion 3.1, 3.1a to 3.1d, have the common release button 84o on the seat.

~~In the 1st embodiment (Figs. 19 to 21) the height and width adjusting mechanism 27 comprises a frame 29, buckle assembly 18.3, 19.3, a pair of tubes 27.4, members 27.5 to 27.9 and a pair of tubes 27.1 having a plurality of locking slots, in form and force locking connection with an angle fitting 26a. The frame 29 consists of a pair of outer tubes 27.3, a pair of tubes 27.2 and a connecting member of all tubes. The locking handle 27.5 is form and force locking connected to the slots of the inner tubes 27.4.~~

These inner tubes 27.4, inserted into the outer tubes 27.3, are pre-loaded by the springs 27.6. Each spring 27.6 on a sleeve 27.7, secured by pin 27.8, protruding through the holes of the inner tube 27.4, presses against the spring rest 27.9 of the outer tube 27.3.

The locking handle 27.5 is in engagement with a pair of locking slots of tubes 27.1. The locking handle 27.5, when pulled out from both slots, is detached therefrom. The height of mechanism 27 and buckle assembly can be adjusted

The outer tube 27.3 is provided with a plurality of locking slots q, r, s etc., drawn with dotted lines in Figs. 20, 22.

After the pawl 18.10, pre-loaded by the spring 18.5, is detached from the locking slot r by its movement in the direction of arrow (Fig. 21), the housing 18.12, form-locking connected to the buckle assembly 4c, can be moved along both outer tubes 27.3.

Belt detachable U-shaped latch plates 25 offer the passengers a feature to adapt their body proportions to the appropriate attachment points into which the latch plates 25 are inserted (Figs. 19, 23). Any belt portion, such as 1.1, 1.2, is loosely guided thereby, secured by a quick-release pin 25.1 thereof and detached therefrom by pulling the quick-release pin.

For juxtaposed seats in vehicles, buses, trains and aeroplanes it is recommended to use a single locking handle 27.5 to operate the 2nd embodiment of the height and width adjusting mechanism 27a of each seat 3c having, for example, three pairs of openings 18.1 /19.1 to 18.3 /19.3 to receive a pair of latch plates (Figs. 22, 23).

The frame 29a consists of two pairs of outer tubes 27.3, two pairs of tubes 27.2, a pair of connecting members of all tubes and members 18.3, 19.3, 27.6 to 27.9a, 27.11, attached to the outer tubes 27.3.

The locking handle 27.5 is form and force-locking connected to slots of the inner tubes 27.4 by the pins 27.12. After inserting these inner tubes into the outer tubes 27.3 the locking plate 27.10 is form and force-locking connected to the slots of the inner tubes and to the pins 27.12.

After securing the spring rest 27.9a by the retaining rings 27.11, both sleeves 27.7a by the pins 27.8, protruding through the holes of inner tubes 27.4 and oblong holes of outer tubes 27.3, the inner tubes with locking handle 27.5 are pre-loaded by springs 27.6. The locking handle 27.5, when pulled out from both slots, is detached therefrom. The height of height and width adjusting mechanism 27a can be adjusted.

Although the present invention has been described and illustrated in detail, it is clearly understood that the terminology used is intended to describe rather than limit. Many more objects, embodiments, features and variations of the present invention are possible in light of the above-mentioned teachings. Therefore, within the spirit and scope of the appended claims,  
5 the present invention may be practised otherwise than as specifically described and illustrated.



What is claimed:

Claims (cancelled) 1 to 4, 6 to 17, 19 to 25, 27 to 37, 40 and 42

5 Claim 51. (currently amended) ~~The multi-point seat belt to protect the passenger from~~  
~~submarining according to claim 1, further comprising an anti-submarining latch plate (11, 25)~~  
~~movable along the lap belt portion (1.3)~~ An anti-submarining seat-belt assembly for increasing  
survival chance of a passenger of a transport system in an accident or during in-flight  
turbulence, comprising  
10 a seat belt, consisting of at least one shoulder belt portion, a lap belt portion and an  
extending belt portion (1.1 to 1.4);  
a main buckle assembly (9.1), having a master release button (84) and attached to a stiff first  
transport-system member, generally representing a floor of the transport system adjacent  
to a first seat-side or a seat-cushion frame at the first seat-side or a mid-tunnel of a motor  
vehicle adjacent to the first seat-side;  
15 a lower belt deflector (17), deflecting and loosely guiding the lap belt portion (1.3) or the  
first shoulder belt portion (1.1) and attached to a stiff second transport-system member,  
generally representing the floor of the transport system adjacent to a second seat-side or  
the seat-cushion frame at the second seat-side or the a post section of the motor vehicle  
adjacent to the second seat-side or a side rail of the motor vehicle adjacent to the second  
20 seat-side;  
at least two latch plates (9, 11, 25), the first of which is a main latch plate (9), moveable  
along the lap belt portion (1.3) or the second shoulder belt portion (1.2), and the second is  
an anti-submarining latch plate (11, 25), moveable along the lap belt portion; and  
anti-submarining buckle assemblies, attached to a seat frame of a seat, generally representing  
25 the seat-cushion frame or a seat-backrest frame;  
whereby  
a lower body (96) of the passenger and an upper body (95) are restrained by the lap- and  
shoulder belt portions (1.3, 1.2) when the main latch plate (9) is plug-in connected to the  
main buckle assembly (9.1); and

the lap belt portion which is subdivided into two anti-submarining belt portions (1.3R, 1.3L) to restrain thighs of the passenger when the anti-submarining latch plate is plug-in connected to one of the anti-submarining buckle assemblies.

5 Claim 52. (currently amended) The ~~multi-point seat belt anti-submarining seat-belt assembly~~ to protect the passenger from submarining according to claim 1, further comprising wherein an anti-submarining latch plate (11, 25) movable along the lap belt portion (1.3) which is subdivided into two belt portions (1.3R, 1.3L) to restrain thighs of the passenger when the anti-submarining latch plate is plug-in connected to one of anti-submarining buckle assemblies (7, 8, 8a), housings of which, are located in a the seat cushion (3.1, 3.1a to 3.1d), have a mutual common release button (84o) on the seat where the common release button, when depressed, releases the anti-submarining latch plate.

10 Claim 53. (currently amended) The ~~multi-point seat belt anti-submarining seat-belt assembly~~ to protect the passenger from submarining according to claim 1, further comprising wherein an anti-submarining latch plate (11, 25) movable along the lap belt portion (1.3) which is subdivided into two belt portions (1.3R, 1.3L) to restrain thighs of the passenger when the anti-submarining latch plate is plug-in connected to one of anti-submarining buckle assemblies assembly (7, 8, 8a8d), housing of which, is located in on a the seat cushion (3.1, 3.1a to 3.1d), have is provided with a mutual release button (84do) on the seat, which, when depressed, releases the anti-submarining latch plate.

20 Claim 414. (currently amended) The ~~multi-point seat belt anti-submarining seat-belt assembly~~ according to claim 402, wherein the master release button (84) is provided with release cables (4.2) connecting to release buttons of the anti-submarining buckle assemblies and a release wire connected to the drive apparatus where the master release button, when depressed, releases the main latch plate and the anti-submarining latch plate from the respective buckle assemblies and returns the belt feeding device to the resting position.

25 Claim 415. (currently amended) The ~~multi-point seat belt anti-submarining seat-belt assembly~~ according to claim 403, wherein the master release button (84) is provided with release cables (4.2) connecting to release buttons of the anti-submarining buckle assemblies and a release wire connected to the drive apparatus where the master release button, when depressed, releases the main latch plate and the anti-submarining latch plate from the respective buckle assemblies and returns the belt feeding device to the resting position.

Claim ~~186~~. (currently amended) The ~~multi-point seat belt anti-submarining seat-belt assembly~~ according to claim ~~142~~, wherein the master release button (84) is provided with release wires connected~~ing~~ to electrical release-motors (4.2b) of release buttons of the ~~anti-submarining~~ buckle assemblies ~~and a release wire connected to the drive apparatus~~ where the master release button, when depressed, releases the main latch plate and the anti-submarining latch plate ~~all the latch plates~~ from the respective buckle assemblies ~~and returns the belt-feeding device to the resting position.~~

Claim ~~187~~. (currently amended) The ~~multi-point seat belt anti-submarining seat-belt assembly~~ according to claim ~~143~~, wherein the master release button (84) is provided with release wires connected~~ing~~ to electrical release-motors (4.2b) of release buttons of the ~~anti-submarining~~ buckle assemblies ~~and a release wire connected to the drive apparatus~~ where the master release button, when depressed, releases the main latch plate and the anti-submarining latch plate ~~all the latch plates~~ from the respective buckle assemblies ~~and returns the belt-feeding device to the resting position.~~

Claim ~~438~~. (currently amended) The ~~multi-point seat belt anti-submarining seat-belt assembly~~ according to claim 1, wherein the supplement anti-submarining latch plate is a belt-detachable latch plate (25), has~~ving~~ a quick-release pin (25.1) and a U-shaped portion to house the lap belt portion which is secured therein by the quick-release pin and detached therefrom by pulling it.

Claim 9. (new) The anti-submarining seat-belt assembly according to claim 8, wherein the anti-submarining belt portions are provided with at least one pair of belt-detachable latch plates, which are plug-in connected to the anti-submarining buckle assemblies in the seat cushion at the first and second seat-side to properly restrain the thighs with small circumference.

Claim ~~510~~. (currently amended) The ~~multi-point seat belt anti-submarining seat-belt assembly~~ ~~to protect the passenger from submarining~~ according to claim ~~19~~, ~~further comprising~~ wherein ~~an anti-submarining latch plate (11, 25) movable along the lap belt portion (1.3) which is subdivided into two belt portions (1.3R, 1.3L) to restrain thighs of the passenger when the anti-submarining latch plate is plug-in connected to one of anti-submarining buckle assemblies (7, 8, 8a), housings of which, are located in a~~ the seat cushion (3.1, 3.1a to 3.1d),

have a ~~mutual~~ common release button (84o) on the seat where the common release button, when depressed, releases all the anti-submarining latch plates.

Claim ~~41~~11. (currently amended) The ~~multi-point seat belt anti-submarining seat-belt assembly~~ according to claim ~~409~~, wherein the master release button (84) is provided with release cables (4.2) connecting to release buttons of the anti-submarining buckle assemblies and a release wire connected to the drive apparatus where the master release button, when depressed, releases the main latch plate and all the anti-submarining latch plates from the respective buckle assemblies and returns the belt-feeding device to the resting position.

Claim 12. (new) The anti-submarining seat-belt assembly according to claim 10, wherein the anti-submarining latch plates, when not being used, are stored and secured in a storage box (25.5) of the seat.

Claim 13. (new) The anti-submarining seat-belt assembly according to claim 11, wherein the anti-submarining latch plates, when not being used, are stored and secured in a storage box (25.5) of the seat.

Claim ~~39~~14. (currently amended) The ~~multi-point seat belt anti-submarining seat-belt assembly~~ to protect the passenger from submarining according to claim ~~311~~, wherein the free-moving anti-submarining latch plate (11, 25) is movable along the lap belt portion (1.3) which is subdivided into two belt portions (1.3R, 1.3L) to restrain thighs of the passenger when the anti-submarining latch plate is plug-in connected to one of anti-submarining buckle assemblies (8b, 8c), a housing of which is free-moving on the seat cushion, each of which is provided with a release button (84e, 84f) and a length-adjustable belt, and attached to a the seat frame cushion.

Claim 15. (new) The anti-submarining seat-belt assembly according to claim 14, wherein the free-moving anti-submarining buckle assembly is provided with an electrical release-motor (4.2b), which, when receiving an electrical signal emitted from the main buckle assembly resulting from depressing the main release button releasing the main latch plate, pulls the release button to release the anti-submarining latch plate.

Claim ~~26~~16. (currently amended) The ~~multi-point seat belt anti-submarining seat-belt assembly~~ according to claim ~~2414~~, wherein the belt end (ER) of the first shoulder belt portion

~~(1.1)~~ length-adjustable belt is provided with a coupling fitting ~~(1.2a, 1.2b)~~ to receive energy absorbers.

Claim 17. (new) The multi-point seat belt anti-submarining seat-belt assembly according to claim 14, wherein the length-adjustable belt has a property of absorbing energy.

5 Claim 18. (new) The multi-point seat belt anti-submarining seat-belt assembly according to claim 16, wherein the length-adjustable belt has a property of absorbing energy.

Claim ~~26~~19. (currently amended) The multi-point seat belt anti-submarining seat-belt assembly according to claim 241, wherein the belt end (ER) of the first shoulder belt portion  
10 ~~(1.1)~~ anti-submarining buckle assembly is provided with a coupling fitting (1.2a, 1.2b) to receive energy absorbers.

Claim ~~5~~20. (currently amended) The multi-point seat belt to protect the passenger from submarining according to claim 1, further comprising an anti-submarining latch plate (11, 25) moveable along the lap belt portion (1.3)  
15 An anti-submarining seat-belt assembly for increasing survival chance of a passenger of a transport system in an accident or during in-flight turbulence, comprising

a two-point seat belt, which is a lap belt portion, a first end of which is fastened to a lower belt deflector (17) and a second is loosely attached to a main latch plate (9);

a main buckle assembly (9.1), having a master release button (84) and attached to a stiff first transport-system member, generally representing a floor of the transport system adjacent  
20 to a first seat-side or a seat-cushion frame at the first seat-side or a mid-tunnel of a motor vehicle adjacent to the first seat-side;

the lower belt deflector (17), attached to a stiff second transport-system member, generally representing the floor of the transport system adjacent to a second seat-side or the seat-cushion frame at the second seat-side or a post section of the motor vehicle adjacent to the  
25 second seat-side or a side rail of the motor vehicle adjacent to the second seat-side;

at least two latch plates (9, 11, 25), the first of which is the main latch plate (9) and the second is an anti-submarining latch plate (11, 25), moveable along the lap belt portion; and  
anti-submarining buckle assemblies, attached to a seat frame of a seat, generally representing the seat-cushion frame or a seat-backrest frame;

30 whereby

5 | a lower body (96) of the passenger is restrained by the lap belt portion when the main latch plate (9) is plug-in connected to the main buckle assembly (9.1); and  
the lap belt portion is subdivided into two anti-submarining belt portions (1.3R, 1.3L) to restrain thighs of the passenger when the anti-submarining latch plate is plug-in connected to the anti-submarining buckle assembly.